

What is claimed is:

1. A plasma processing method for forming a fluorine-containing carbon film on a surface of a substrate by using
5 a plasma processing apparatus including a processing chamber in which a mounting table is provided; a disc-shaped planar antenna member disposed at an upper portion of the processing chamber to face the mounting table, a plurality of slots for radiating a microwave being circumferentially
10 formed in the planar antenna member; a dielectric plate disposed under the planar antenna member, the dielectric plate transmitting the microwave radiated from the planar antenna member; and a conductive gas supply member disposed between the dielectric plate and the mounting table to
15 divide the inside of the processing chamber into an upper plasma generation space and a lower processing space, the gas supply member having a plurality of through-holes and a plurality of gas supply openings, the plasma generation space and the processing space communicating with each other
20 through the through-holes, wherein the method repeating at least two times the following steps of (a) to (e):

(a) mounting the substrate on the mounting table in the processing chamber;

(b) forming a fluorine-containing carbon film of a
25 predetermined thickness on the surface of the substrate on the mounting table, which includes: (b1) supplying a rare

gas into the plasma generation space, (b2) supplying a film forming gas, which is a compound gas containing carbon and fluorine, into the processing space through the gas supply openings of the gas supply member, and (b3) activating the rare gas and the film forming gas by radiating the microwave from the planar antenna member to deposit active species generated from the film forming gas;

(c) unloading the substrate on which the film is formed out of the processing chamber;

(d) after the step (c), by supplying a cleaning gas containing oxygen into the processing chamber and radiating the microwave from the planar antenna member to activate the cleaning gas, cleaning inner surfaces of the processing chamber including a bottom surface of the dielectric plate with oxygen active species generated from the cleaning gas; and

(e) after the step (d), by supplying the film forming gas into the processing chamber and radiating the microwave from the planar antenna member to activate the film forming gas, forming a precoat film of fluorine-containing carbon thinner than the fluorine-containing carbon film formed in the step (b) on the inner surfaces of the processing chamber including the bottom surface of the dielectric plate with active species generated from the film forming gas.

2. The plasma processing method of claim 1, wherein the

steps (d) and (e) are performed under the condition that a dummy substrate is mounted on the mounting table in the processing chamber.

5 3. The plasma processing method of claim 1, wherein the gas supply member is made of aluminum or an aluminum alloy.

10 4. The plasma processing method of claim 3, wherein between the steps (d) and (e), there is provided a step of, by supplying a gaseous mixture of an oxygen-containing gas and a rare gas into the processing chamber and radiating the microwave from the planar antenna member to activate the gaseous mixture, oxidizing the surface of the gas supply member with oxygen radicals generated from the gaseous mixture.

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20 5. The plasma processing method of claim 3, wherein instead of the step (e), there is provided a step of, by supplying a gaseous mixture of an oxygen-containing gas and a rare gas into the processing chamber and radiating the microwave from the planar antenna member to activate the gaseous mixture, oxidizing the surface of the gas supply member with oxygen radicals generated from the gaseous mixture.

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6. The plasma processing method of claim 5, wherein the

step (d) is performed under the condition that a dummy substrate is mounted on the mounting table in the processing chamber.

5 7. A plasma processing apparatus for forming a fluorine-containing carbon film on a surface of a substrate by using a film forming gas which is a compound gas containing carbon and fluorine, the plasma processing apparatus comprising:

10 a processing chamber in which a mounting table is provided;

a transfer mechanism for transferring the substrate between the inside and the outside of the processing chamber;

15 a disc-shaped planar antenna member disposed at an upper portion of the processing chamber to face the mounting table, a plurality of slots for radiating a microwave being circumferentially formed in the planar antenna member;

20 a dielectric plate disposed under the planar antenna member, the dielectric plate transmitting the microwave radiated from the planar antenna member;

a conductive gas supply member disposed between the dielectric plate and the mounting table to divide the inside of the processing chamber into an upper plasma generation space and a lower processing space, the gas supply member having a plurality of through-holes and a plurality of gas supply openings, the plasma generation space and the

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processing space communicating with each other through the through-holes;

a gas supply line for supplying a cleaning gas containing oxygen into the processing chamber; and

5 a controller for executing a control of repeating at least two times the following steps of (a) to (e):

(a) mounting the substrate on the mounting table in the processing chamber;

10 (b) forming a fluorine-containing carbon film of a predetermined thickness on the surface of the substrate on the mounting table, which includes: (b1) supplying a rare gas into the plasma generation space, (b2) supplying a film forming gas, which is a compound gas containing carbon and fluorine, into the processing space through the gas supply
15 openings of the gas supply member, and (b3) activating the rare gas and the film forming gas by radiating the microwave from the planar antenna member to deposit active species generated from the film forming gas;

20 (c) unloading the substrate on which the film is formed out of the processing chamber;

(d) after the step (c), by supplying a cleaning gas containing oxygen into the processing chamber and radiating the microwave from the planar antenna member to activate the cleaning gas, cleaning inner surfaces of the processing
25 chamber including a bottom surface of the dielectric plate with oxygen active species generated from the cleaning gas;

and

5 (e) after the step (d), by supplying the film forming gas into the processing chamber and radiating the microwave from the planar antenna member to activate the film forming gas, forming a precoat film of fluorine-containing carbon thinner than the fluorine-containing carbon film formed in the step (b) on the inner surfaces of the processing chamber including the bottom surface of the dielectric plate with active species generated from the film forming gas.